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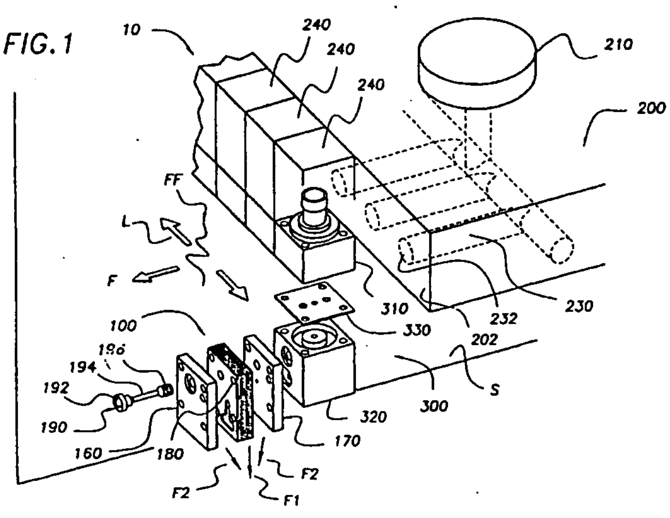
(54) Meltblowing method and system

(57) A meltblowing method and system for dispensing first and second fluids (F1,F2) from corresponding first and second orifices of a die assembly (100) to form a meltblown first fluid filament (FF). The die assembly (100) directs the first and second fluid flow flows parallelly, or divergently, or directs the two second fluid flows convergently toward a common first fluid flow, whereby the first and second fluids are dispensed from orifices at equal first fluid flow rates and equal second fluid flow rates. The die assembly (100) is compressibly retained between opposing end plates (160,170) coupled to an adapter (320) for further coupling to a main manifold (10) having a fluid metering device (210) for supplying first fluid to the die assembly. The meltblown filaments are depositing onto a moving substrate (S) by vacillating the filament non-parallel to a direction of substrate movement, whereby vacillation a first fluid flow is controllable by an angle between the first fluid flow and one or more flanking second fluid flows, among other variables.

FIG. 1



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Description

The invention relates generally to meltblowing methods and systems, and more particularly to parallel plate meltblowing die assemblies and meltblowing system configurations useable for precisely controlling the dispensing and uniform application of meltblown adhesive filaments onto moving substrates.

Meltblowing is a process of forming fibers or filaments by drawing and attenuating a first fluid flow with shear forces from adjacent relatively high velocity second fluid flows. Molten thermoplastic flows, for example, may be drawn and attenuated by heated air flows to form meltblown thermoplastic filaments. Generally, meltblown filaments may be continuous or discontinuous, and range in size between several tenths of a micron and several hundred microns depending on the meltblown material and application requirements. Early applications for meltblowing processes included the formation of non-woven fabrics from meltblown filaments drawn to vacillate chaotically.

More recently, meltblowing processes have been used to form meltblown adhesive filaments for bonding substrates in the production of a variety of bodily fluid absorbing hygienic articles like disposable diapers and incontinence pads, sanitary napkins, patient underlays, and surgical dressings. Many of these applications, however, require a relatively high degree of control over the dispensing and application of the meltblown filaments, particularly meltblown adhesives deposited onto substrates which are extremely temperature sensitive. But meltblown filaments drawn to vacillate chaotically are not generally suitable for these and other applications requiring increased control over the dispensing and application of the meltblown filaments.

EP-A-0835952 of earlier priority date to this case, marked a significant advance in meltblowing technologies, and particularly for meltblowing applications requiring relatively precise control over the dispensing of individual meltblown filaments onto moving substrates. The referenced copending application is drawn generally to parallel plate die assemblies having a plurality of adhesive and air dispensing orifices arranged in a variety of spatial configurations for dispensing meltblown adhesives, and more particularly for relatively precisely controlling frequency and amplitude parameters of individual meltblown filaments to provide selective and uniform application of the filaments onto moving substrates.

The present invention is drawn to further advances in meltblowing technology, and is applicable to the dispensing of meltblown adhesive filaments onto moving substrates, especially in the production of bodily fluid absorbing hygienic articles.

According to a first aspect of this invention a meltblowing method comprises

dispensing a first fluid from a first orifice to form a first fluid flow at a first velocity;
dispensing a second fluid from not more than two second orifices associated with the first orifice to form separate second fluid flows at a second velocity along substantially opposing flanking sides of the first fluid flow;
convergently directing the separate second fluid flows toward the first fluid flow; and,
drawing the first fluid flow with the second fluid flow at a second velocity greater than the first velocity of the first fluid flow,
wherein the drawn first fluid flow is attenuated to form a first fluid filament.

According to a second aspect of this invention a meltblown apparatus comprises

a first orifice in a body member for dispensing a first fluid and forming a first fluid flow;
not more than two second orifices in the body member associated with the first orifice for dispensing a second fluid and forming two second fluid flows;
the first orifice protruding relative to the second orifices, and
the first orifice and the two second orifices arranged, and
the first orifice and the two second orifices arranged so that the first orifice is flanked on substantially opposing sides by the two second orifices, the two second orifices oriented to convergently direct the two second fluid flows toward the first fluid flow.

Particular embodiments in accordance with this invention will now be described with reference to the accompanying drawings; in which:-

Figure 1 is meltblowing system including an exploded view of a meltblowing die assembly comprising a plurality of parallel plates coupleable by an adapter to a manifold having a fluid metering device for supplying a first fluid to a plurality of meltblowing die assemblies similarly coupled to the manifold;
Figures 2a-2i represent a plurality of individual parallel plates of a die assembly, or body member, according to an exemplary embodiment of the invention;
Figure 3a is a frontal plan view of a first die retaining end plate for compressibly retaining a die assembly of the type shown Figures 2;
Figure 3b is a sectional view along lines I - I of Figure 3a;
Figure 4 is a frontal plan view of a second die retaining end plate for compressibly retaining a die assembly in cooperation with the first die retaining end plate;
Figure 5a is frontal plan view of a die assembly adapter;
Figure 5b is an end view along lines II - II of Figure

5a;

Figure 5c is sectional view along lines III - III of Figure 5a;

Figure 6a is a sectional view along lines IV - IV of Figure 6b of an intermediate adapter coupleable with the adapter of Figure 5;

Figure 6b is a frontal plan view of the intermediate adapter of Figure 6a; and,

Figure 6c is a top plan view along lines V - V of the intermediate adapter of Figure 6b;

Figure 1 is meltblowing system 10 useable for dispensing fluids, and particularly hot melt adhesives, onto a substrate S movable in a first direction F relative thereto. The system 10 includes generally one or more meltblowing die assemblies 100, an exemplary one of which is shown having a plurality of at least two parallel plates, coupleable to a manifold 200 having associated therewith a fluid metering device 210 for supplying a first fluid to the one or more meltblowing die assemblies through corresponding first fluid supply conduits 230. The system also has the capacity to supply a second fluid like heated air to the die assemblies as discussed more fully in EP-A-0819477.

According to one aspect of the invention shown schematically in Figure 1, a first fluid is dispensed from a first orifice of the die assembly 100 to form a first fluid flow F1 at a first velocity, and a second fluid is dispensed from two second orifices to form separate second fluid flows at a second velocity F2 along substantially opposing flanking sides of the first fluid flow F1. The first fluid flow F1 located between the second fluid flows F2 thus forms an array of first and second fluid flows. The second velocity of the second fluid flows F2 is generally greater than the first velocity of the first fluid flow F1 so that the second fluid flows F2 draw the first fluid flow, wherein the drawn first fluid flow is attenuated to form a first fluid filament. In the exemplary embodiment, the second fluid flows F2 are directed convergently toward the first fluid flow F1, but more generally the second fluid flows F2 are directed nonconvergently relative to the first fluid flow F1 in parallel or divergently as disclosed more fully in EP-A-0835952.

More generally, the first fluid is dispensed from a plurality of first orifices to form a plurality of first fluid flows F1, and the second fluid is dispensed from a plurality of second orifices to form a plurality of second fluid flows F2, wherein the plurality of first fluid flows and the plurality of second fluid flows are arranged in a series. In convergently directed second fluid flow configurations, the plurality of first fluid flows F1 and the plurality of second fluid flows F2 are arranged in a series so that each of the plurality of first fluid flows F1 is flanked on substantially opposing sides by corresponding convergently directed second fluid flows F2 as shown in Figure 1, i.e. F2 F1 F2 F2 F1 F2. In non-convergently directed second fluid flow configurations, the plurality of first fluid flows F1 and the plurality of second fluid flows F2 are arranged in an alternating series so that each of the plurality of first fluid flows F1 is flanked on substantially opposing sides by one of the second fluid flows F2, i.e. F2 Fl F2 Fl F2, as disclosed more fully in EP-A-0835952. The second velocity of the plurality of second fluid flows F2 is generally greater than the first velocity of the plurality of first fluid flows also that the plurality of second fluid flows F2 draw the plurality of first fluid flows, wherein the drawn plurality of first fluid flows are attenuated to form a plurality of first fluid filaments. The plurality of first fluid flows Fl are generally alternatively directed divergently, or parallelly, or convergently.

According to another aspect of the invention, the plurality of first fluid flows Fl are dispensed from the plurality of first orifices at the same first fluid mass flow rate, and the plurality of second fluid flows F2 are dispensed from the plurality of second orifices at the same second fluid mass flow rate. The mass flow rates of the plurality of first fluid flows, however, is not necessarily the same as the mass flow rates of the plurality of second fluid flows. Dispensing the plurality of first fluid flows at equal first fluid mass flow rates provides improved first fluid flow control and uniform dispensing of the first fluid flows from the die assembly 100, and dispensing the plurality of second fluid flows at equal second fluid mass flow rates ensures more uniform and symmetric control of the first fluid flows with the corresponding second fluid flows as discussed further herein. In one embodiment, the plurality of first orifices have equal first fluid flow paths to provide the equal first fluid mass flow rates, and the plurality of second orifices having equal second fluid flow paths to provide the equal second fluid mass flow rates.

In convergently directed second fluid flow configurations, the two second fluid flows F2 convergently directed toward a common first fluid flow Fl generally have equal second fluid mass flow rates. Although the two second fluid mass flow rates associated with a first fluid flow are not necessarily equal to the two second fluid mass flow rates associated with another first fluid flow. In some applications, moreover, the two second fluid flows F2 convergently directed toward a common first fluid flow Fl may have unequal second fluid mass flow rates to affect a particular control over the first fluid flow. Also, in some applications the mass flows rates of some of the first fluid flows are not equal to the mass flow rates of other first fluid flows, for example first fluid flows dispensed along lateral edge portions of the substrate may have a different mass flow rates than other first fluid flows dispensed onto intermediate portions of the substrate to affect edge definition. Thus, while it is generally desirable to have equal mass fluid flow rates amongst first and second fluid flows, there are applications where it is desirable to vary the mass flow rates of some of the first fluid flows relative to other first fluid flows, and similarly to vary the mass flow rates of some of the second fluid flows relative to other second fluid flows.

Figure 1 shows a first fluid flow Fl vacillating under

the effect of the flanking second fluid flows F2, which for clarity are not shown. The first fluid flow FI vacillation is characterizable generally by an amplitude parameter and a frequency parameter, which are controllable substantially periodically or chaotically depending upon the application requirements. The vacillation is controllable, for example, by varying a spacing between the first fluid flow FI and one or more of the second fluid flows F2, or by varying the amount of one or more of the second fluid flows F2, or by varying a velocity of one or more of the second fluid flows F2 relative to the velocity of the first fluid flow FI. The amplitude and frequency parameters of the first fluid flow FI are thus controllable with any one or more of the above variables as discussed more fully in EP-A-0835952.

The vacillation of the first fluid flow F1 also controllable by varying a relative angle between one or more of the second fluid flows F2 and the first fluid flow F1. This method of controlling the vacillation of the first fluid flow FI is useable in applications where the second fluid flows are convergent or non-convergent relative to the first fluid flow F1. Convergently directed second fluid flow configurations permit control of first fluid flow FI vacillation with relatively decreased second fluid mass flow rates in comparison to parallel and divergent second fluid flow configurations, thereby reducing heated air requirements. Generally, the first fluid flow F1 is relatively symmetric when the angles between the second fluid flows F2 on opposing sides of the first fluid flow F1 are equal. Alternatively, the vacillation of the first fluid flow F1 may be skewed laterally one direction or the other when the flanking second fluid flows F2 have unequal angles relative to the first fluid flow F1, or by otherwise varying other variables discussed herein.

According to another aspect of the invention shown in Figure 1, a first fluid flow filament FF from any one of several die assemblies coupled to the main manifold, but not shown, is vacillated substantially periodically non-parallel to a direction F of substrate S movement. The corresponding die assembly generally includes a plurality of fluid flow filaments FF arranged in a series with the illustrated filament non-parallel to the direction F of substrate S movement. Still more generally, a plurality of similar die assemblies are coupled to the main manifold 200 in series, and/or in two or more parallel series which may be offset or staggered, and/or nonparallel to the direction F of substrate S movement. In the exemplary application, the plurality of die assemblies and the fluid flow filaments are vacillated in the directions L transversely to the direction F of the substrate S movement. In some applications, however, it may be advantageous and thus desirable to vacillate one or more of the first fluid flow filaments FF parallel to the direction F of substrate movement. This is particularly so along lateral edge portions of the substrate, where more precise control over application of the hot melt adhesive is desired, for example to effect a well defined edge profile, or boundary. According to this aspect of the invention, the first fluid flow filament FF may be vacillated parallelly to the direction F of substrate movement by orienting the series of first and second orifices of the die assembly parallel to the direction F of substrate movement as discussed further below.

The exemplary die assembly 100 of Figure 1 includes a plurality of plates arranged in parallel and embodying many aspects of the invention as shown in Figures 2a-2i. The plates of Figures 2 are assembled one on top of the other beginning with the plate in Figure 2a on top and ending with the plate in Figure 2i on bottom as a reference. The first and second fluids supplied to the die assembly 100, or body member, are distributed to the first and second orifices as discussed below. The first fluid is supplied from a first restrictor cavity inlet 110 to a first restrictor cavity 112 in the plate of Figure 2a. The first fluid is substantially uniformly distributed from the first restrictor cavity 112 through a plurality of first orifices 118 in the plate of Figure 2b to a first accumulator cavity 120 defined aggregately by the adjacent plates in Figures 2c and 2d. The plurality of first orifices also function as a fluid filter, entrapping any larger debris in the first fluid. The first fluid accumulated in the first accumulator cavity 120 is then supplied to a first plurality of slots 122 in the plate of Figure 2e, which form the plurality of first orifices as discussed further below.

The second fluid is supplied from a second fluid inlet 131 to branched second fluid restrictor cavity inlet arms 132 and 134 formed in the plates of Figures 2a and 2d, through corresponding passages 136 and 138 through the plates of Figures 2e-2h, and into separate second fluid restrictor cavities 140 and 142 in the plate of Figure 2i. The second fluid is substantially uniformly distributed from the separate second restrictor cavities 140 and 142 through a plurality of second orifices 144 in the plate of Figure 2h to a second accumulator cavity 146 defined aggregately by the adjacent plates in Figures 2f and 2g. The plurality of second orifices 144 also function as a fluid filter, entrapping any debris in the second fluid. The second fluid accumulated in the second accumulator cavity 146 is then supplied to a second plurality of slots 123 in the plate of Figure 2e, which form the plurality of second orifices as discussed further below.

The plates of Figures 2d and 2f cover opposing sides of the plate in Figure 2e to form the first and second orifices fluid dispensing orifices. In the exemplary embodiment of Figure 2, the first orifices are oriented divergently relative to each other, and each first orifice has associated therewith two second orifices convergently directed toward the corresponding first orifice. This configuration is illustrated most clearly in Figure 2e. According to a related aspect of the invention, the plurality of first and second orifices of Figure 2e also have equal fluid flow paths as a result of the first and second slots 122 and 123 having similar length fluid flow paths formed radially along an arcuate path. The orifice size is generally between approximately 0.001 and approximately 0.060 inches per generally rectangular side,

whereas in most meltblown adhesive applications the orifice size is between approximately 0.005 and approximately 0.060 inches per generally rectangular side. The first fluid filaments formed by the meltblowing processes discussed herein generally have diameters ranging between approximately 1 micron and approximately 1000 microns.

In alternative embodiments, the first and second orifices of the die assembly 100 may be oriented parallelly or divergently, and the die assembly may include alternating series of first and second orifices. Additionally, the die assembly 100 may include plural arrays of serial first and second orifices arranged in parallel, non-parallel, offset parallel, and on different planer dimensions of the die assembly. These and other features are discussed more fully in EP-A-0835952 which other features are combineable with the many features and aspects of the present invention.

According to another aspect of the invention shown in Figures 1, 3 and 4, the die assembly 100 is compressedly retained between a first die retaining end plate 160 and a second opposing die retaining end plate 170. The die assembly 100 is retained therebetween by a plurality of bolt members, not shown for clarity, extendable through corresponding holes 162 in corners of the first end plate 160, through the corresponding holes 102 in the die assembly, and into the second end plate 170 wherein the bolt members are threadably engaged in corresponding threaded holes 172. The individual plates of Figure 2 that compose the die assembly 100 thus are not bonded, or otherwise retained. The plate is preferably formed of a non-corrosive material like stainless steel.

Figure 1 also shows the individual plates of the die assembly 100 retainable in parallel relationship by a single rivet member 180 disposable through a corresponding hole 104, or opening, formed in each plate of the die assembly 100, which is shown in Figure 2, wherein end portions of the rivet member 180 are protrudable into corresponding recesses or holes 164 and 174 in the first and second end plates 160 and 170 when the die assembly 100 is compressibly retained therebetween. The individual plates of the die assembly 100 are pivotally disposed, or fannable, about the rivet member 180 and are thus largely separable for inspection and cleaning. According to a related aspect of the invention, the rivet member 180 is installed when the die assembly 100 is compressibly retained between the end plates 160 and 170, which precisely aligns the individual plates of the die assembly, by driving the rivet member 180 through holes through the end plates 160, 170 and through the die assembly plates.

Figure 1 also shows the die assembly 100 retained between the first and second end plates 160 and 170 coupleable to an adapter assembly 300 comprising an adapter 310 and an intermediate adapter 320. Figures 5a-5c show various views of the adapter 310 having a first interface 312 for mounting either the die assembly 100 compressibly retained between the end plates 160 and 170 directly or alternatively for mounting the intermediate adapter 320 as shown in the exemplary embodiment. The mounting interface 312 of the adapter 310 includes a first fluid outlet 314 coupled to a corresponding first fluid inlet 315, and a second fluid outlet 316 coupled to a corresponding second fluid inlet 317. The intermediate adapter 320 having a first mounting surface 322 with first and second fluid inlets 324 and 326 coupled to corresponding first and second fluid outlets 325 and 327 on a second mounting interface 321. The first mounting surface 322 of the intermediate adapter 320 is mountable on the first mounting interface 312 of the adapter 310 to couple the first and second fluid inlets 324 and 326 of the intermediate adapter 320 to the first and second fluid outlets 314 and 316 of the adapter 310.

According to another aspect of the invention shown in Figures 5b, 6a and 6c, the first fluid outlet 314 of the adapter 310 is located centrally thereon for coupling with a centrally located first fluid inlet 324 of the intermediate adapter 320. The second fluid outlet 316 of the adapter 310 is located radially relative to the first fluid outlet 314 for coupling with a recessed annular second fluid inlet 328 coupled to the second fluid inlet 326 and disposed about the first fluid inlet 324 on the first interface 322 of the intermediate adapter 320.

According to this aspect of the invention, the intermediate adapter 320 is rotationally adjustable relative to the adapter 310 to adjustably orient the die assembly 100 mounted thereon to permit alignment of the die assembly parallel or non-parallel to the direction F of substrate movement as discussed herein. And according to a related aspect of the invention, the adapter 310 also has a recessed annular second fluid inlet disposed about the first fluid inlet 315 and coupled to the second fluid outlet 316, whereby the adapter 310 is rotationally adjustable relative to a nozzle module 240 or other adapter for coupling the die assembly 100 to a first fluid supply as discussed further herein.

Figures 5b and 5c show the first interface of one of the adapter 310 or intermediate adapter 320 having first and second sealing member recesses 318 and 319 disposed about the first and second fluid outlets 314 and 316 on the first interface 312 of the adapter 310. A corresponding resilient sealing member like a rubber o-ring, not shown but known in the art, is seatable in each recess for forming a fluid seal between the adapter 310 and the intermediate adapter 320. The exemplary recesses are enlarged relative to the first and second fluid outlets 314 and 316 to accommodate misalignment between the adapter 310 and the intermediate adapter 320 and additionally to prevent contact between the first fluid and the sealing member, which may result in premature seal deterioration. Also, some of the recesses are oval shaped to more efficiently utilize the limited surface area of the mounting interface 312. The second fluid inlet 317 and other interfaces generally have a similar sealing member recess for forming a fluid seal with correspond-

ing mounting members not shown.

Figure 1 also shows a metal sealing member, or gasket, 330 disposable between the adapter 310 and the intermediate adapter 320 for use in combination with the resilient sealing member discussed above or as alternative thereto, which may be required in food processing and other applications. The metal sealing member 330 generally includes first and second fluid coupling ports, which may be enlarged to accommodate the resilient scaling members discussed above, and holes for passing bolt members therethrough during coupling of the adapter 310 and intermediate adapter 320.

As discussed herein, the die assembly 100 compressibly retained between the first and second end plates 160 and 170 is coupleable either directly to the adapter 310 or to the intermediate adapter 320 thereby permitting mounting of the die assembly 100 in a parallel or vertical orientation, or in orientations shifted 90 degrees. Figure 1 shows the die assembly 100 and die retaining end plates 160 and 170 mounted on the second mounting interface 321 of the intermediate adapter 320, but the mounting interfaces of the adapter 310 and the intermediate adapter 320 for this purpose are functionally equivalent. Figure 4 shows the second die retaining end plate 170 having a first fluid inlet 176 and a second fluid inlet for coupling the first and second fluid inlets 112 and 132, 134 of the die assembly 100 with the first and second fluid outlets 325 and 327 of the intermediate adapter 320.

Figure 1 shows a fastener 190 for fastening the die assembly 100 retained between the end plates 160 and 170 to the mounting surface of the adapter 320. The fastener 190 includes an enlarged head portion 192 with a torque applying engagement surface, a narrowed shaft portion 194, and a threaded end portion 196. Figure 3a shows the first end plate 160 having an opening 166 for freely passing the threaded end portion 196 of the fastener 190 therethrough, and a seat 167 for receiving a sealing member, not shown, which forms a fluid seal with the enlarged head portion 192 of the fastener 190 advanced fully through the die assembly 100. The threaded end portion 196 of the fastener 190 is also freely passable through the second fluid inlet 131 of the die assembly 100 of Figure 2, through the hole 178 in the second end plate 170, and into threaded engagement with a portion 329 of the second fluid outlet 327 of the intermediate adapter 320. According to this aspect of the invention, the fastener 190 is disposed through and into the second fluid outlet 327 of the adapter 320, or adapter 310 which is configured similarly, to fasten the die assembly 100 compressibly retained between the first and second end plates 160 and 170, whereby the narrowed shaft portion 194 of the fastener 190 permits the second fluid flow therethrough without obstruction.

According to a related aspect of the invention, the hole 170 in the second end pate 170 is threaded to engage the threaded end portion 196 of the fastener thereby preventing separation thereof during assembly of the die assembly 100 and the end plates 160 and 170. According to another aspect of the invention, the fastener 190 extends through an upper portion of the die assembly 100 and die retaining end plates 160 and 170 to facilitate mounting thereof onto the mounting interface of the adapter 310 or 320. This upward location of the fastener 190 allows gravitational orientation of the die assembly relative to the adapter when mounting to substantially vertically oriented mounting interfaces. The adapter mounting interface and the second end plate 170 may also have complementary members for positively locating the second end plate 170 on the mounting interface. Figures 4 and 6b, for example, show for this purpose a protruding member 179 on the second end plate 170 and a complementary recess 323 on the second mounting interface 321 of the intermediate adapter 320.

According to yet another aspect of the invention shown in Figure 1, the die assembly 100 is coupled to a fluid metering device 210 for supplying the first fluid to the die assembly. The die assembly is coupled to the main manifold 200 having a first fluid supply conduit 230 coupleable between the fluid metering device 210 and the die assembly 100 to supply first fluid thereto. The exemplary embodiment shows, more generally, accommodations for mounting a plurality of die assemblies 100 coupled to the main manifold 200, wherein the main manifold has a plurality of first fluid supply conduits 230 coupleable between the fluid metering device 210 and a corresponding one of the plurality of die assemblies 100 to supply first fluid thereto. The first fluid supply conduits 230 are coupled to a plurality of corresponding fluid outlet ports 232 disposed on a first end portion 202 of the main manifold 200, wherein the plurality of die assemblies 100 are coupled to the first end portion 202 of the main manifold 200.

In one application, each die assembly 100 and corresponding adapter 310 and or 320 is coupled to the main manifold 200 by a corresponding nozzle module 240 having an actuatable valve for controlling supply of first and second fluids to the die assembly, for example an MR-1300TM Nozzle Module, available from ITW Dynatec, Hendersonville, Tennessee. In an alternative application, each die assembly 100 and corresponding adapter 310 and or 320 is coupled to the main manifold 200 by a common nozzle adapter plate, which supplies the first and second fluids to the plurality of die assemblies. According to this configuration, the modules 240 in Figure 1 form the common adapter plate. These and other features and aspects of the invention are more fully disclosed in EP-A-0819477, which other features are also combineable with the many features and aspects of the present invention.

In still another alternative application, each die assembly 100 and corresponding adapter 310 and or 320 is coupled to the main manifold 200 by a corresponding one of a plurality of individual first fluid flow control plates

240, which supplies first and second fluids to corresponding die assemblies. And in another alternative embodiment, each of the plurality of individual first fluid flow control plates 240 is also coupled to the main manifold 200 by the common fluid return manifold for returning first fluid to the main manifold. These and other features and aspects of the invention are more fully disclosed in EP-A-0836891.

Claims

1. A meltblowing method comprising the steps of:

    dispensing a first fluid from a first orifice to form a first fluid flow at a first velocity;
    dispensing a second fluid from not more than two second orifices associated with the first orifice to form separate second fluid flows at a second velocity along substantially opposing flanking sides of the first fluid flow;
    convergently directing the separate second fluid flows toward the first fluid flow; and,
    drawing the first fluid flow with the second fluid flow at a second velocity greater than the first velocity of the first fluid flow,
    wherein the drawn first fluid flow is attenuated to form a first fluid filament.

2. A method according to claim 1, further comprising the steps of controlling a vacillation of the first fluid flow with an angle between at least one of the separate second fluid flows and the first fluid flow.

3. A method according to any one of the preceding claims, further comprising the steps of:

    dispensing the first fluid from a plurality of first orifices to form a plurality of first fluid flows at the first velocity;
    dispensing the second fluid form a plurality of second orifices to form a plurality of second fluid flows at the second velocity, the plurality of first fluid flows and the plurality of second fluid flows arranged in a series so that each of the plurality of first fluid flows is flanked on substantially opposing sides by corresponding convergently directed second fluid flows; and
    drawing the plurality of first fluid flows with the corresponding convergently directed second fluid flows at the second velocity greater than the first velocity of the plurality of fluid flows,
    wherein the drawn plurality of first flows are attenuated to form a plurality of first fluid filaments.

4. A method according to claim 3, further comprising the step of divergently directing the plurality of first fluid flows.

5. A method according to claim 3, comprising the step of directing the plurality of first fluid flows in parallel.

6. A method according to claim 3 or 4, further comprising steps of dispensing the first fluid from a plurality of first orifices at equal mass flow rates, and dispensing the convergently directed second fluid flows from a plurality of second orifices at equal mass flow rates.

7. A method according to any one of the preceding claims, further comprising the step of depositing the first fluid filament or filaments onto a moving substrate by vacillating them non-parallel to a direction of substrate movement.

8. A method according to any one of the preceding claims, further comprising the step of dispensing the first fluid from one or more first orifices protruding relative to the second orifices associated with the one or more orifices.

9. A method according to any one of the preceding claims, further comprising the step of dispensing the second fluid from the second orifices recessed in corresponding apertures relative to the one or more first orifices.

10. A meltblowing apparatus comprising:

    a first orifice in a body member for dispensing a first fluid and forming a first fluid flow;
    not more than two second orifices in the body member associated with the first orifice for dispensing a second fluid and forming two second fluid flows;
    the first orifice protruding relative to the second orifices, and,
    the first orifice and the two second orifices arranged, and
    the first orifice and the two second orifices being arranged so that the first orifice is flanked on substantially opposing sides by the two second orifices, the two second orifices being oriented to convergently direct the two second fluid flows toward the first fluid flow.

11. An apparatus according to claim 10, further comprising:

    a plurality of first orifices in the body member for dispensing the first fluid and forming a plurality of first fluid flows;
    a plurality of second orifices in the body member for dispensing the second fluid and forming a plurality of second fluid flows;

the plurality of first orifices protruding relative to the plurality of second orifices, and
the plurality of first orifices and the plurality of second orifices arranged in a series so that each of the plurality of first orifices is flanked on substantially opposing sides by corresponding second orifices to convergently direct two second fluid flows towards each first fluid flow.

12. An apparatus according to claim 10 or 11, wherein the body member is a die assembly comprising:

a first plate forming a first restrictor cavity in the body member, the first restrictor cavity having a first restrictor cavity inlet and a first restrictor cavity outlet;
a second plate forming first accumulator cavity in the body member, the first accumulator cavity having a first accumulator cavity inlet coupled to the first restrictor cavity outlet, and the first accumulator cavity having a first accumulator cavity outlet coupled to the plurality of first orifices,
wherein first fluid supplied to the first restrictor cavity inlet is substantially uniformly distributed to the plurality of first orifices to form the plurality of first fluid flows.

13. An apparatus according to claim 12, the body member further comprising a third plate between the first plate and the second plate, the third plate having a plurality of first passages coupling the first restrictor cavity and the first accumulator cavity, wherein the plurality of passages in the third plate are dimensioned to substantially uniformly distribute the first fluid supplied from the first restrictor cavity to the plurality of first orifices.

14. An apparatus according to claim 13, the body member further comprising:

a fourth plate forming a second restrictor cavity in the body member, the second restrictor cavity having a second restrictor cavity inlet and a second restrictor cavity inlet;
a fifth plate forming a second accumulator cavity in the body member, the second accumulator cavity having a second accumulator cavity inlet coupled to the second restrictor cavity inlet, and the second accumulator cavity having a second accumulator cavity outlet coupled to the plurality of second orifices,
wherein second fluid supplied to the second restrictor cavity inlet is substantially uniformly distributed to the plurality of second orifices to form the plurality of second fluid flows.

15. An apparatus according to claim 14, the body member further comprising a sixth plate between the fourth plate and the fifth plate, the sixth plate having a plurality of second passages coupling the second restrictor cavity and the second accumulators cavity, wherein the plurality of passages in the sixth plate substantially uniformly distribute the second fluid supplied from the second restrictor cavity to the plurality of second orifices.

16. An apparatus according to claim 15, the body member further comprising a seventh plate having a first plurality of slots and a second plurality of slots, the first plurality of slots forming the first plurality of orifices coupled to the first accumulator cavity and the second plurality of slots forming the second plurality of orifices coupled to the second accumulator cavity.

17. An apparatus according to any one of claims 10 to 16, wherein the plurality of first orifices have equal first fluid flow paths, and the plurality of second orifices have equal second fluid flow paths.

18. An apparatus according to any one of claims 10 to 16, wherein the plurality of orifices are oriented to direct the plurality of first fluid flows in parallel.

19. An apparatus according to any one of claims 10 to 18, wherein the plurality of first orifices are oriented to divergently direct the plurality of first fluid flows.

20. An apparatus according to any one of claims 10 to 19, wherein the second orifices are disposed in a corresponding aperture of the body member to recess the second orifices in the body member relative to the first orifice.

21. A meltblowing apparatus comprising:

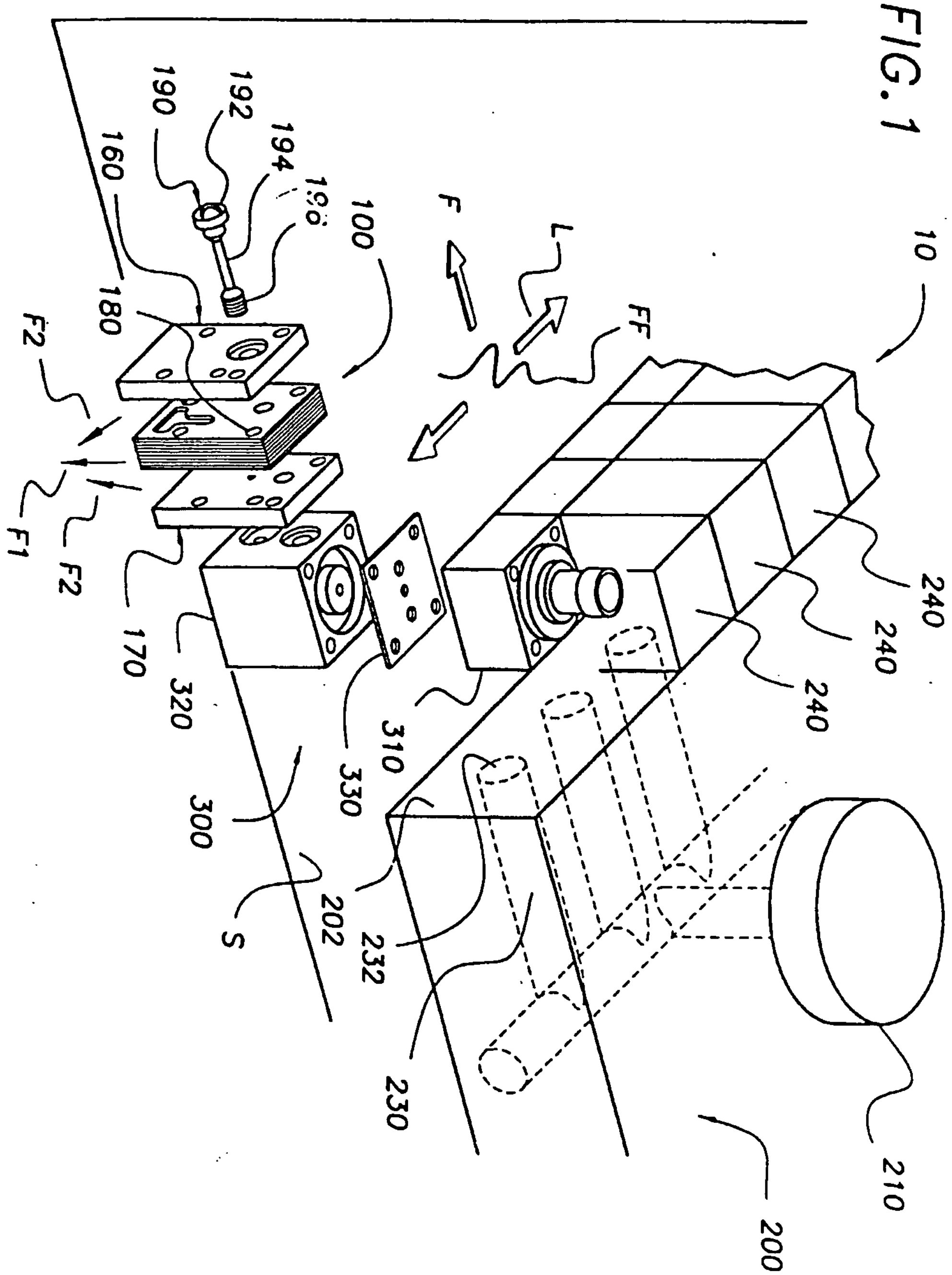
a plurality of first orifices in a body member for dispensing a first fluid and forming a plurality of first fluid flows;
a plurality of second orifices in the body member for dispensing a second fluid and forming a plurality of second fluid flows;
the plurality of first orifices and the plurality of second orifices arranged in a series so that each of the plurality of first orifices is flanked on substantially opposing sides by corresponding second orifices,
the plurality of first orifices protruding relative to the plurality of second orifices and,
at least some adjacent first orifices of the series separated by at least two adjacent second orifices of the series.

22. A meltblowing apparatus according to claim 21, wherein, the body member is a die assembly com-

prising a plurality of at least two parallel plates, the plurality of first orifices and the plurality of second orifices formed in at least one of the two parallel plates of the die assembly.

23. An apparatus according to claim 22, wherein each plate is not thicker than approximately 0.030 inches (0.76mm).

24. An apparatus according to claim 22 or 23, wherein each plate has a thickness between approximately 0.005 inches (0.127mm) and approximately 0.025 inches (0.635mm).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F2
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210
200

FIG. 1

FIG.2a

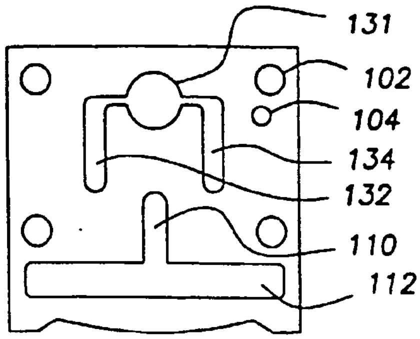


FIG.2d

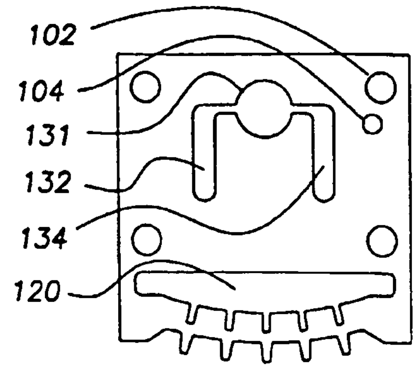


FIG.2b

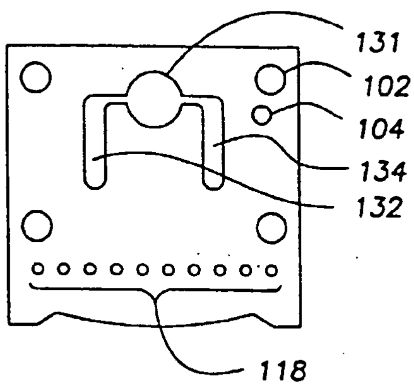


FIG.2e

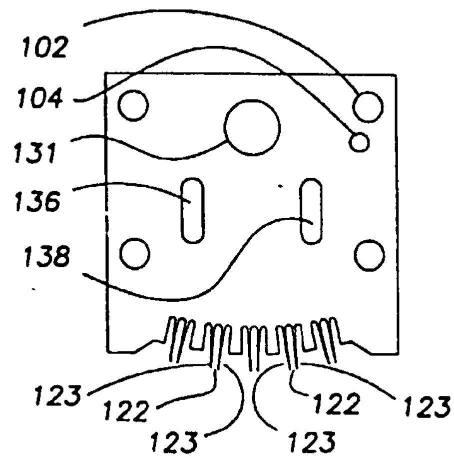


FIG.2c

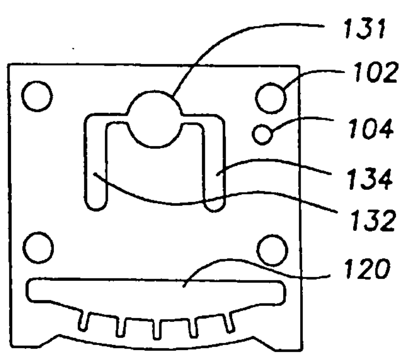


FIG.2f

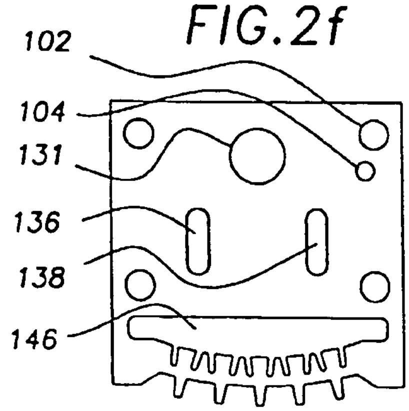


FIG.2g

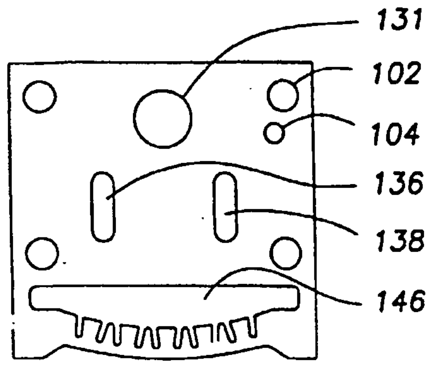


FIG.3a

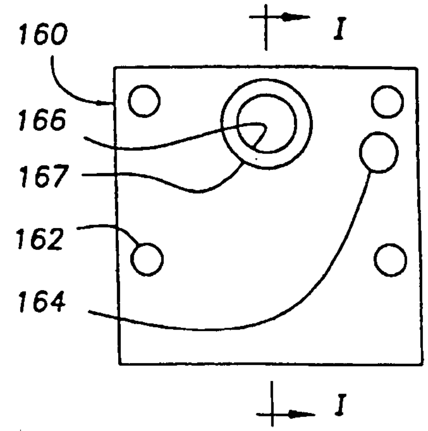


FIG.2h

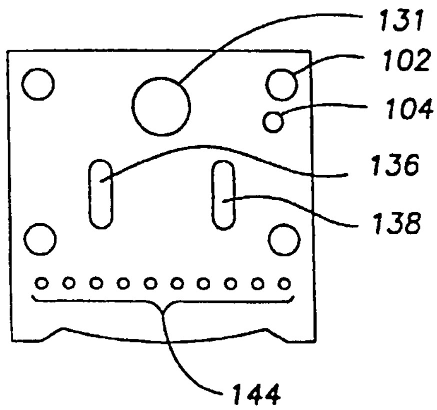


FIG.3b

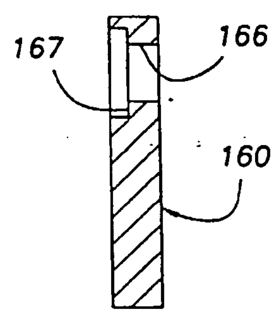


FIG.2i

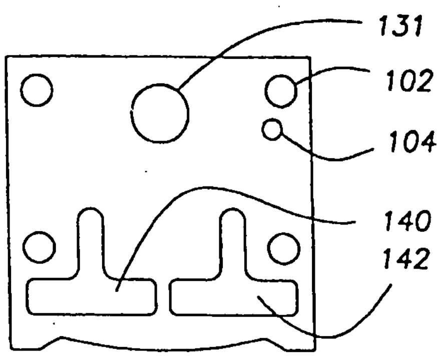


FIG.4

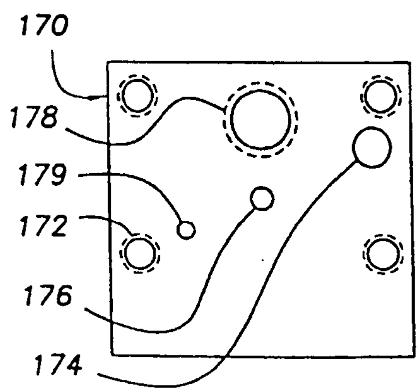


FIG.5a

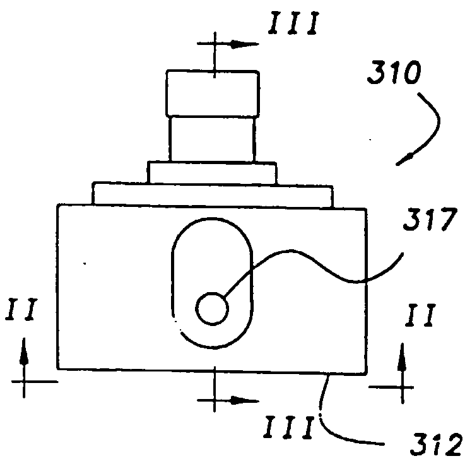


FIG.5c

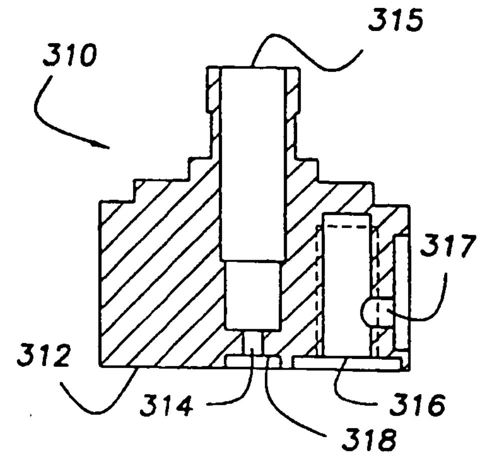


FIG.5b

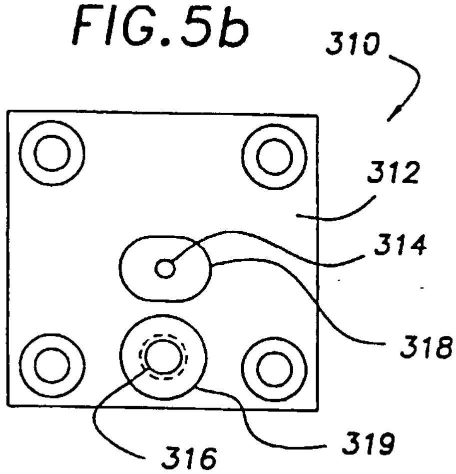


FIG.6a

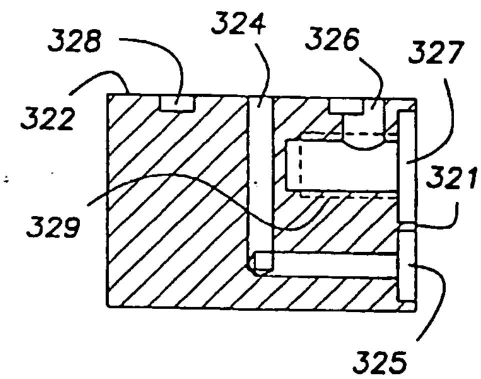


FIG.6b

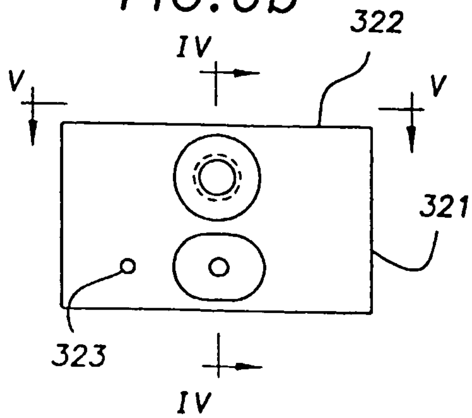
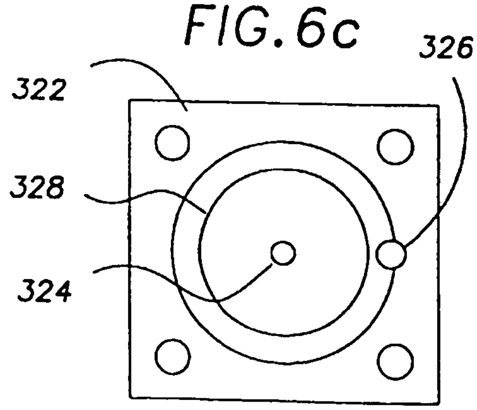


FIG.6c



European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 98 30 2718

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
X	US 5 618 566 A (ALLEN MARTIN A ET AL) 8 April 1997 * column 1, line 4 - line 8 * * column 4, line 10 - line 40; figures 4-9 *	1-3,5,7,8,10-12,21,22	D01D4/02
X	US 4 785 996 A (ZIECKER ROGER A ET AL) 22 November 1988 * abstract; figures 1,2 *	1-3,7	
X	US 4 380 570 A (SCHWARZ ECKHARD C A) 19 April 1983 * abstract; figure 8 *	21,22	
A	US 5 017 116 A (CARTER DON E ET AL) 21 May 1991 * column 2, line 47 - line 68; figures 1-6 *	12-16	

TECHNICAL FIELDS SEARCHED (Int.Cl.6)
D01D

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
MUNICH	4 August 1998	Westermayer, W

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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